

THE WEATHER AND CIRCULATION OF OCTOBER 1953<sup>1</sup>

## The Beginning of Drought Alleviation

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REVIEW <sup>2</sup>

From June through September various sections of the United States were subjected to extreme drought conditions [1]. The major disaster areas shifted from time to time as temporary local relief occurred [2, 3], but only the Southeast and the extreme Northwest experienced a persistent abundance of precipitation. During September, in particular, the drought intensified over wide areas from Arizona to New England. By the end of September it was evident that a repetition of last October's (1952) weather—the driest month on record in the United States [4]—would result in a most serious situation.

## DROUGHT ALLEVIATION

This year, however, even early October gave evidence of some relief. During the first week a polar trough traversed the country spreading precipitation in a band from Texas to Michigan. Additional precipitation occurred as the cold air behind the associated front arrived over the Northeast and was effectively overrun by warm, moist air from a disturbance of tropical origin off the coast. In this manner temporary relief from extreme drought conditions was afforded appreciable sections of the critically dry area.

Following this promising interlude there was a return to the previous dry regime. Except for the extreme Southeast, Northeast, and Northwest, little precipitation of note occurred. The upper level ridge rebuilt over western North America and trough activity prevailed just off the east coast. This typical drought-producing circulation was accompanied by the frequently noted temperature pattern of warm in the West, cold in the East. The characteristics of such circulation and temperature patterns were recently described by Klein [1].

This reestablishment of the drought regime posed a question which commonly confronts prognosticators—Was the temporary break of early October a forerunner or precursory sign of a gradual relaxation of the prevailing (drought) pattern or merely an incidental interruption

of a continuing regime? Between the 10th and 14th of the month circulation changes began to occur which signified that the more optimistic interpretation was the correct one.

The mean 700-mb. contours for October 10–14 (fig. 1a) showed the following important features: (1) A fast, flat cyclonic flow in the eastern Pacific with a sheared trough strongly tilted from northwest to southeast. This circulation implied transport of westerly momentum southward into the southwestern United States [5]. Usually the transition is accompanied by advection of cool maritime air, frontal and possibly cyclonic activity, and precipitation. (2) The ridge formerly over western North America had begun to move eastward particularly at lower latitudes. In this instance the ridge was located over Oklahoma—an area well recognized as unfavorable for prolonged anticyclonic circulation (except in summer) since it lies in the lee of the Continental Divide. Fairly rapid eastward translation of ridges located in this area usually occurs. (3) The east coast trough had made eastward motion and the mid-latitude (45° N.) wavelength was becoming very long.

The concomitant temperature anomaly (fig. 1b) reflected these changes. Cool maritime air had begun to penetrate the Far West as the center of warm air shifted eastward with the ridge, and the below normal areas of the East were confined almost exclusively to the area east of the Appalachians. The precipitation map (fig. 1c), showed continuation of the prevailing dry regime. The upper level High over southern Texas prevented any sizable quantities of Gulf moisture from invading the United States. Precipitation had already spread down to central California, and by the end of the period some precipitation had been released as far east as the Panhandle.

Figure 2 depicts the mean state for the 5-day period 1 week later, October 17–21. The shear in the Pacific trough was now complete and the southern trough segment had entered the western United States.<sup>3</sup> It was now an independent trough in the long wave pattern and provided the necessary relaxation (at middle and lower latitudes) between the widely spaced mid-Pacific and western Atlantic troughs. The North American ridge,

<sup>3</sup> A detailed investigation of some upper level aspects of this transition is described in an adjacent article by C. L. Kibler and E. F. Robinson.

<sup>1</sup> See Charts I–XV following p. 347 for analyzed climatological data for the month.

<sup>2</sup> Detailed statistics on this year's drought and comparison with previous great droughts are contained in a special issue of the *Weekly Weather and Crop Bulletin*, vol. XL, No. 45, November 6, 1953.

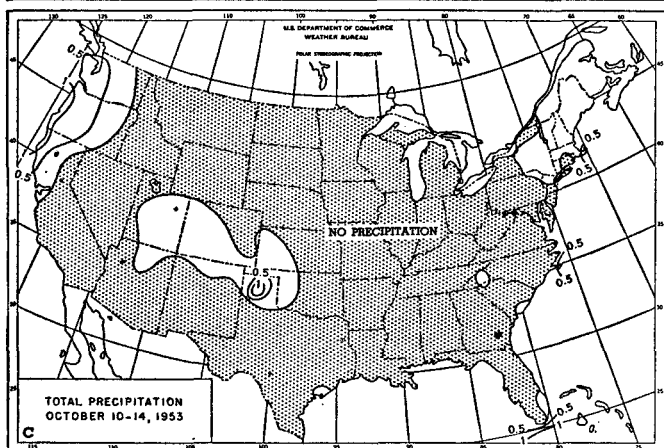
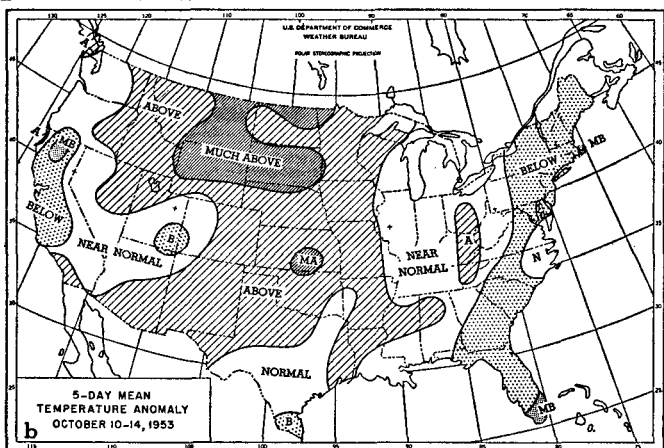
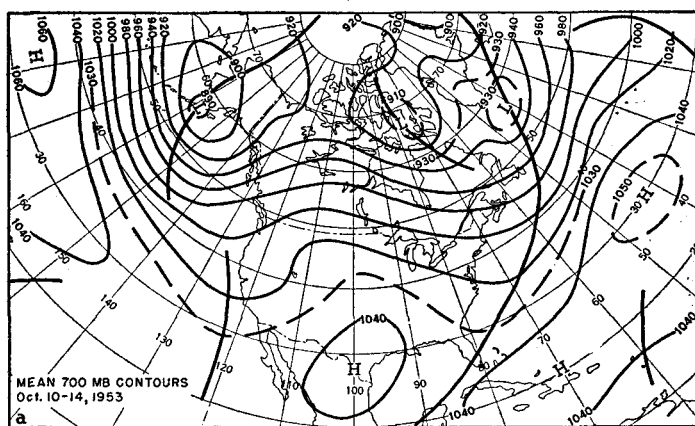


FIGURE 1.—Five-day means for October 10-14, 1953. a. 700-mb. heights in tens of feet. In the Pacific a tilted trough (actually sheared) with strong west-northwesterlies to its rear preceded the southeastward transport of angular momentum and cyclonic vorticity into the United States. b. Temperature anomalies showing the eastward shift of warm air and the initiation of cooling in the Far West as polar maritime air began its penetration. c. Precipitation totals (in inches) indicate continuation of the drought but with significant amounts appearing in the Far Northwest.

at lower latitudes, had shifted eastward to the Appalachians and tilted northwestward through central Canada.

Figures 2b and 2c show the results of these circulation changes on the weather. Polar maritime air effected below normal temperatures over most of the Far West in the upper level trough. Above and much above normal temperatures were generally found throughout the large ridge system over the East and in the southwesterly flow ahead of the trough. A more significant change is

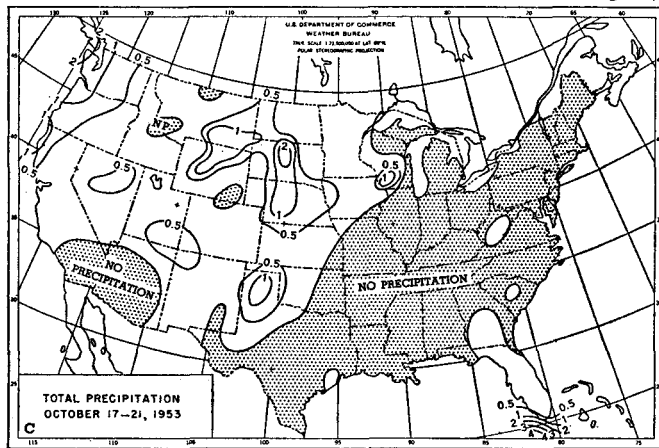
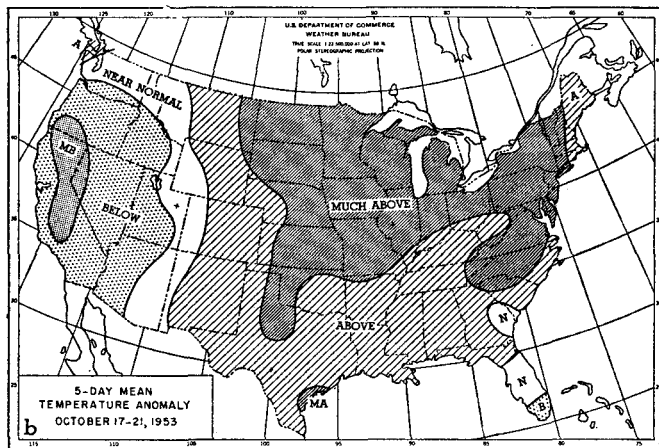
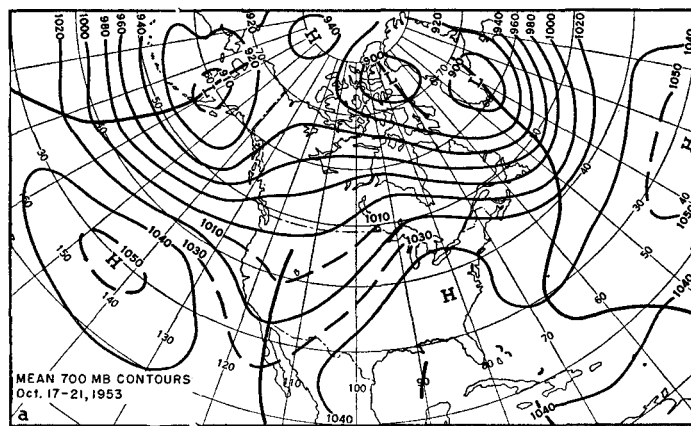


FIGURE 2.—Five-day means for October 17-21, 1953, 1 week later than figure 1. a. 700-mb. heights in tens of feet. Note increase of westerlies and cyclonic vorticity over western United States. Ridge has advanced westward and no longer prevents advection of moisture from the Gulf of Mexico. b. Temperature anomalies. Cold and warm temperature anomalies shifted eastward with upper level circulation features and cold maritime air dominated in the West. c. Precipitation totals (in inches) show spread of precipitation eastward as trough advanced alleviating drought in many areas.

evident in the precipitation pattern which shows that the rains spread from the Pacific Coast to the Panhandle and northeastward to the upper Mississippi Valley. Areas with a half inch or more, while fairly numerous and occasionally extensive, failed by far to cover all of the western drought area. Nevertheless, this represented the most extensive spread of appreciable precipitation in over a month and revived the hopes of hard-hit agricultural interests. At the beginning of this period (October 17)

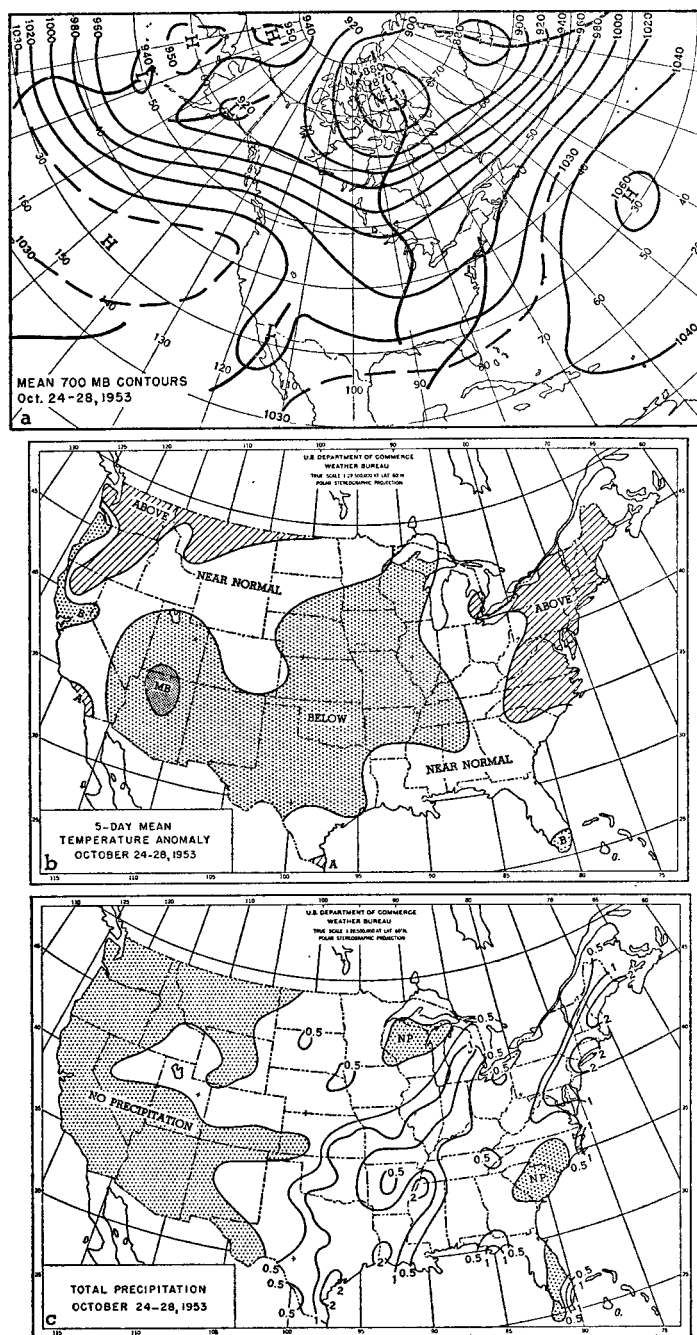


FIGURE 3.—Five-day means for October 24–28, 1953, 1 week later than figure 2. a. 700-mb. height in tens of feet. Absorption of major portions of the United States trough into the main westerly belt was accompanied by another trough shear and widespread cyclonic circulation in the United States. b. Temperature anomaly pattern is almost the reverse of that in figure 1b and accompanies circulation changes cited. c. Precipitation totals (in inches). Widespread precipitation associated with the upper level cyclonic circulation occurred in significant amounts and ended the drought in many localities.

and later on the 26th, the Mississippi River at Memphis reached the lowest stage (–3.3 feet) in 80 years of record.

The mean map 1 week later, October 24–28 (fig. 3a) shows the subsequent transition. As the trough intensified in the central Pacific a strong ridge built up along the west coast, particularly at middle latitudes. This development was accompanied by a rapid eastward motion of the portion of the United States trough which sheared

completely from the low-latitude piece over Lower California and the southern Colorado River Valley. During this time the western Atlantic trough of the previous week became cut off, retrograded as a closed Low and, as shown here, finally weakened and was absorbed again into the westerly stream. The result was a broad area of cyclonic circulation over central and eastern areas of the United States.

Further extension of the cold air into central and southwestern United States accompanied this change as shown in figure 3b. While cooling itself usually mitigates drought conditions, the more important effect was the eastward spread of precipitation. Figure 3c shows appreciable precipitation over central and northeastern areas, with lesser amounts over much of the Appalachian region.

In summary: Many of the areas suffering intense drought received real relief during October. Precipitation was quite widespread (see Charts II and III) but not everywhere adequate for general relief. Temporarily at least, the drought was assuaged, but continued precipitation would be necessary to prevent immediate reintensification.

The effect of the drought on agriculture varied greatly with the locale and the main crop or activity. Paradoxically, the country's principal crops were excellent. Major corn areas were north of the most intense drought or the crop was too far advanced to be ruined by late summer aridity. Cotton survived with less weevil infestation partially making up for the drier weather. Wheat had been far enough along to mature where affected, and the rains came early enough so that fall seeding or reseeding held fair prospects. The cattlemen, in general, were hardest hit where pastures browned off and feed and water were scarce. In the East, extensive damage to smaller crops was fairly common. However, a fall drought insures good harvesting weather and in essence the total agricultural product was well above normal and harvested in record time.

### MONTHLY CIRCULATION FEATURES

As a result of the marked transitions just discussed the monthly average contours (fig. 4) at 700 mb. lacked strong definition over the United States. A weak trough in the Far West and a slack gradient at lower latitudes across the United States were the reflection of these changes. The major North American characteristic was an above normal height anomaly center (+250 feet) over Ontario, Canada, which indicates the North American westerlies were farther north and stronger than normal over Canada and much weaker than normal over the United States. Figure 5, the standardized deviations of the mean heights, reveals that the Canadian anomaly center was greater than twice the standard deviation, a highly significant departure.

Inspection of adjacent areas shows the Pacific dominated by broad cyclonic circulation, strong westerlies, and greater storm activity than usual in the Gulf of Alaska.

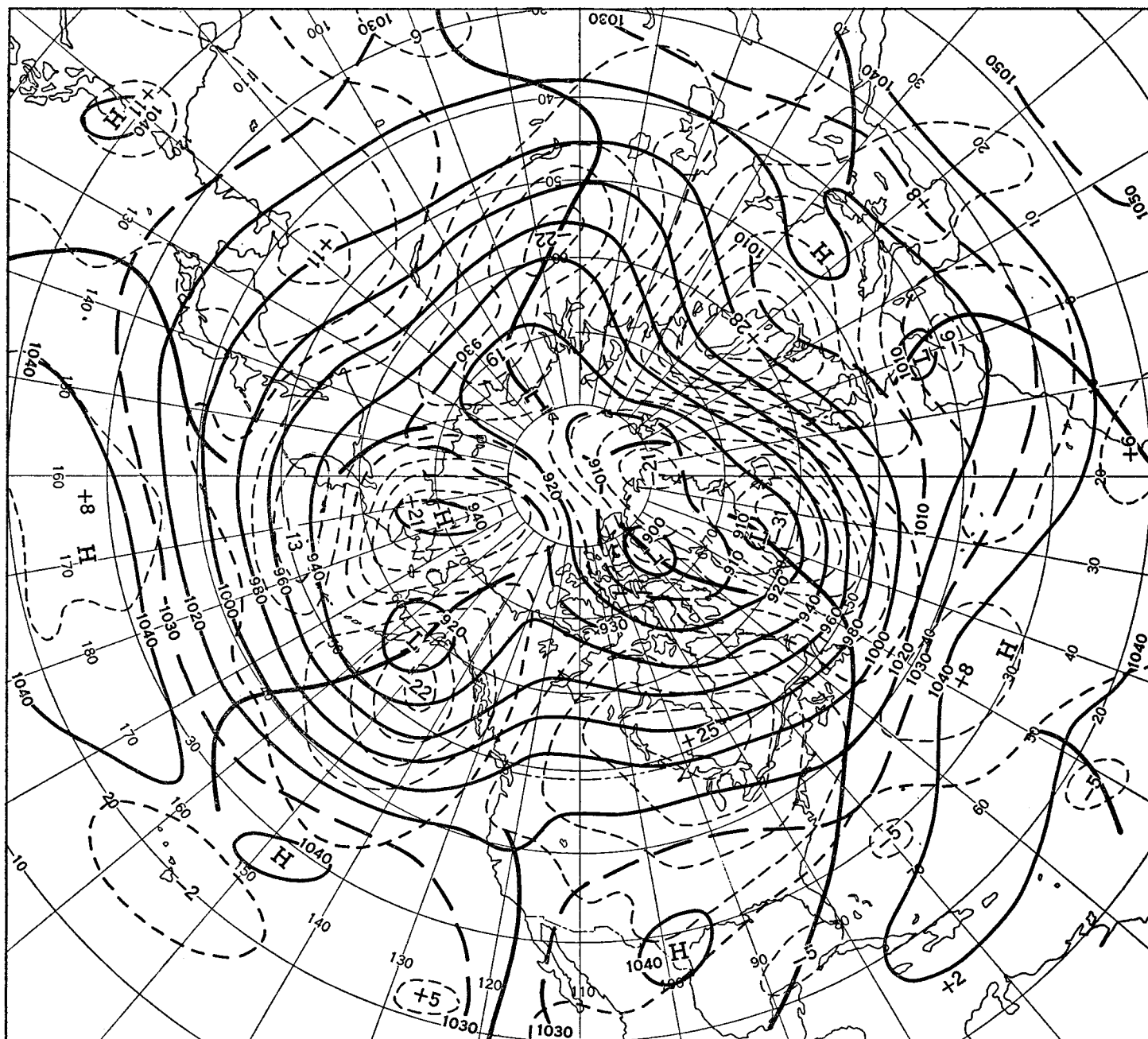


FIGURE 4.—Mean 700-mb. height contours and departures from normal (both in tens of feet) for September 29–October 28, 1953. Weak gradients and poor definition of pattern features over southern United States were reflections of transitions within the month. Abnormally strong Aleutian and Icelandic Lows accompanied oceanic high index regimes. Westerlies over North America were farther north and stronger than normal with heights averaging 250 feet above normal in south-central Canada. Note blocking over Europe and associated low latitude westerlies in Mediterranean.

The Gulf Low was remarkably persistent—sea level pressures averaged 6 mb. below normal (Chart XI)—and the numerous individual cyclones which contributed to this activity are tracked on Chart X. Quite a few of these impulses crossed the Canadian mountain regions (at the surface and/or aloft) and gave rise to eastward moving cyclones in the fast westerlies across Canada. Some of these storms contributed to cyclonic activity in the Davis Strait while others, passing south of Greenland, were joined by northeastward moving storms from the Atlantic Coast trough (fig. 4) and led to intense cyclonic activity

near Iceland (see Charts X and XI). This was the area of the greatest standardized departure from normal, i. e.,  $2.2\sigma$ .

Europe was the scene of recurrent surges of blocking. Heights averaged 280 feet above normal over the Baltic Sea area. Typical fast westerlies carried many perturbations over the top of the ridge. To the south, in the Mediterranean, a characteristic (of blocking) low-latitude Low was associated with repeated cyclonic activity. Heavy rains and widespread flooding—the result of these slow-moving perturbations—were reported from northern

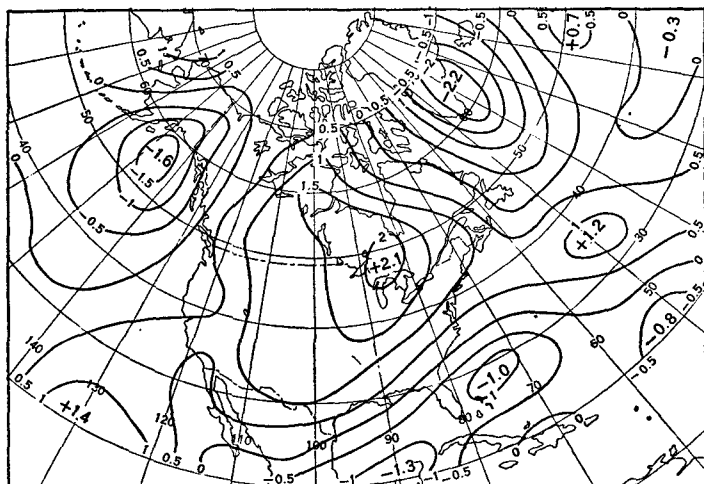


FIGURE 5.—Mean 700-mb. height departures from normal (September 29–October 28, 1953) in units of  $\sigma$ , the standard deviation. Heights in southern Canada and southeastern Greenland were greater than twice the local standard deviation.

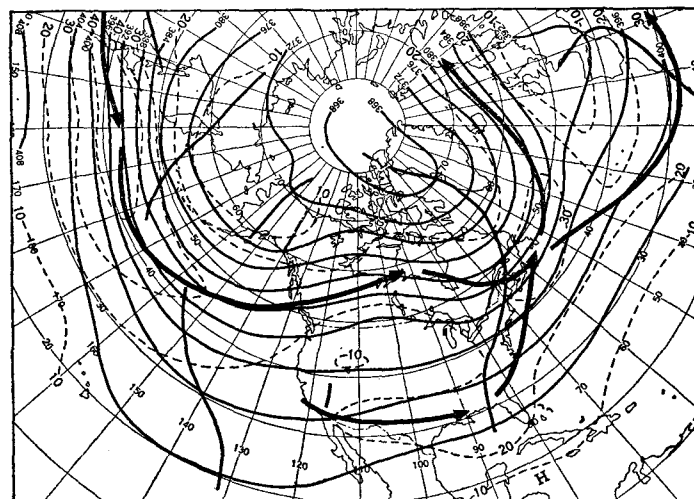


FIGURE 6.—Mean 200-mb. contours (in hundreds of feet) and isotachs (in meters per second) for September 29–October 28, 1953. Solid arrows show strong wind maxima in western oceanic regions with definite split maxima over North America and Europe.

Spain on the 14th, the Italian Riviera on the 15th, and disastrous floods occurred in southern Italy (Calabria) several days later.

At the 200-mb. level the mean contours and wind speeds (fig. 6) illustrate once again the development of high level westerly maxima to the south of blocks and to the south of strong above normal anomaly areas located in mid-latitudes. Over both North America and Europe the high level westerlies showed well-defined double maxima. This European split is recognized as characteristic of blocking activity. The split over North America seems to typify many situations in which the mid-latitude westerlies are displaced northward (at lower levels) without the development of a definite block but with the development of a low-latitude west wind maximum at higher elevations. In the western portions of both oceans a single well-defined west wind maximum was located in the areas of frequent development of wave cyclones.

#### UNITED STATES WEATHER

In view of the preceding discussion one would expect the major storm track to be located in central Canada, north of the maximum west winds, with relatively little cyclonic activity over the United States. Chart X reveals that relatively few cyclones occurred within the United States borders. Conversely, south of the west wind maximum, anticyclonic passages were quite frequent (Chart IX) in the region of anticyclonic relative vorticity at 700 mb. (not shown).

Under this general regime widespread excessive precipitation would be inconsistent with observed circulation. Charts II and III show that while many States received drought-moderating precipitation, a majority of States had less than normal amounts. Most of the significant precipitation has been mentioned in the preceding pages.

Apart from the rains already discussed, heavy precipitation occurred along the extreme Northwest Coast, where trailing fronts and upper level troughs gave orographically modified precipitation amounts. In Florida where the 700-mb. circulation was persistently cyclonic, copious rains gave a statewide average total of 5.84 in. (139 percent of normal).

The monthly temperature anomaly (Chart I) was one of abnormal warmth. Temperatures averaged 8° F. above normal in North Dakota with the positive departures diminishing over the United States in all directions. Temperatures were slightly below normal in the Southwest, Texas, and the extreme Southeast. This pattern can be readily associated with the mean circulation characteristics of the month. The flat ridge over western Canada (fig. 4) and the strong westerlies well to the north prevented deep cold continental outbreaks from periodically entering the United States. Rather, the southern half of North America was mostly under the influence of slow-moving modified Pacific air masses. At this time of the year these can characteristically effect below normal temperatures only in the lower latitudes. This appears well related to the observed pattern except perhaps for Florida where persistent cloudiness and rain provided the cooling mechanism (Charts VI and VII).

#### NEWSWORTHY ASPECTS OF THE WEATHER

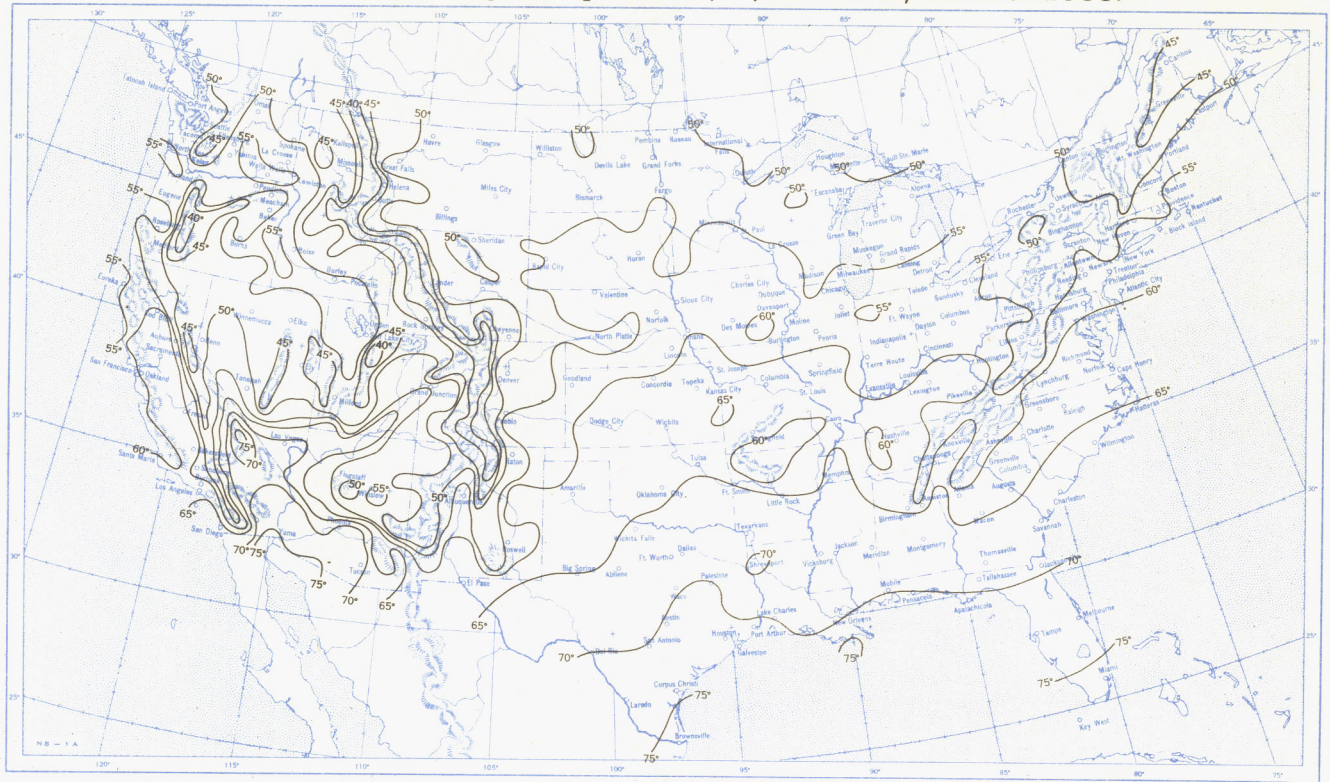
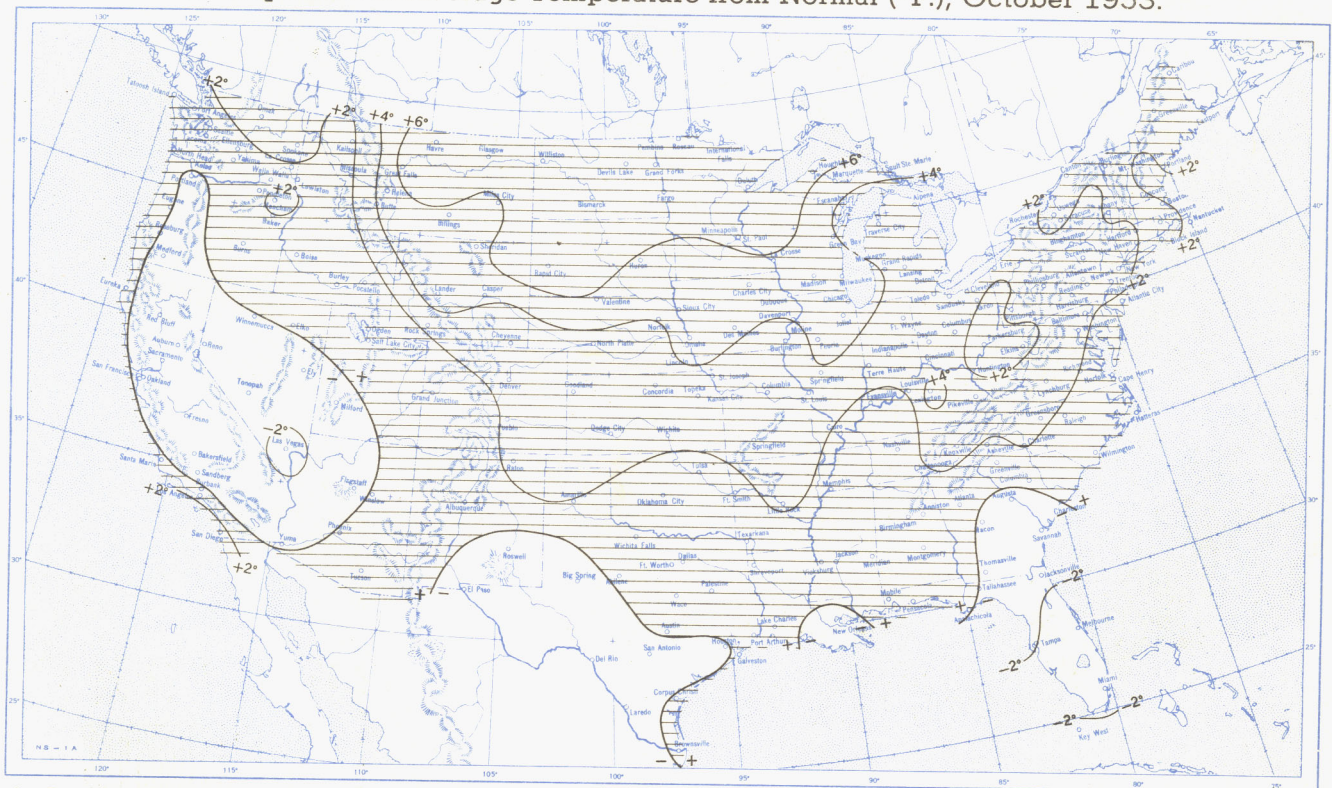
Drought and its variations, recessions, and advances were continuously in the news throughout the month. Announcements of a Federal drought aid program, applications for assistance, closing of public lands and national forests to hunting and recreation, failure of wells, and lowering of water tables—all were commonly met news stories. The drought's alleviation was commensurately popular and items such as Amarillo's 2-week total (ending

October 26) rainfall of 4.56 inches, which was almost half of the year's accumulation to date, received wide attention.

Other items were the warmth of early October. Bismarck, N. Dak., experienced a record 95° F. on the 1st, while 101 at Los Angeles and Burbank, Calif., was noted on the 5th. Both Fargo and Devils Lake, N. Dak., had their warmest October on record. No full-fledged hurricanes affected the continental United States during the month although one tropical storm did cross lower Florida (on the 9th) as it moved northeastward from the warm seas near Yucatan.

#### REFERENCES

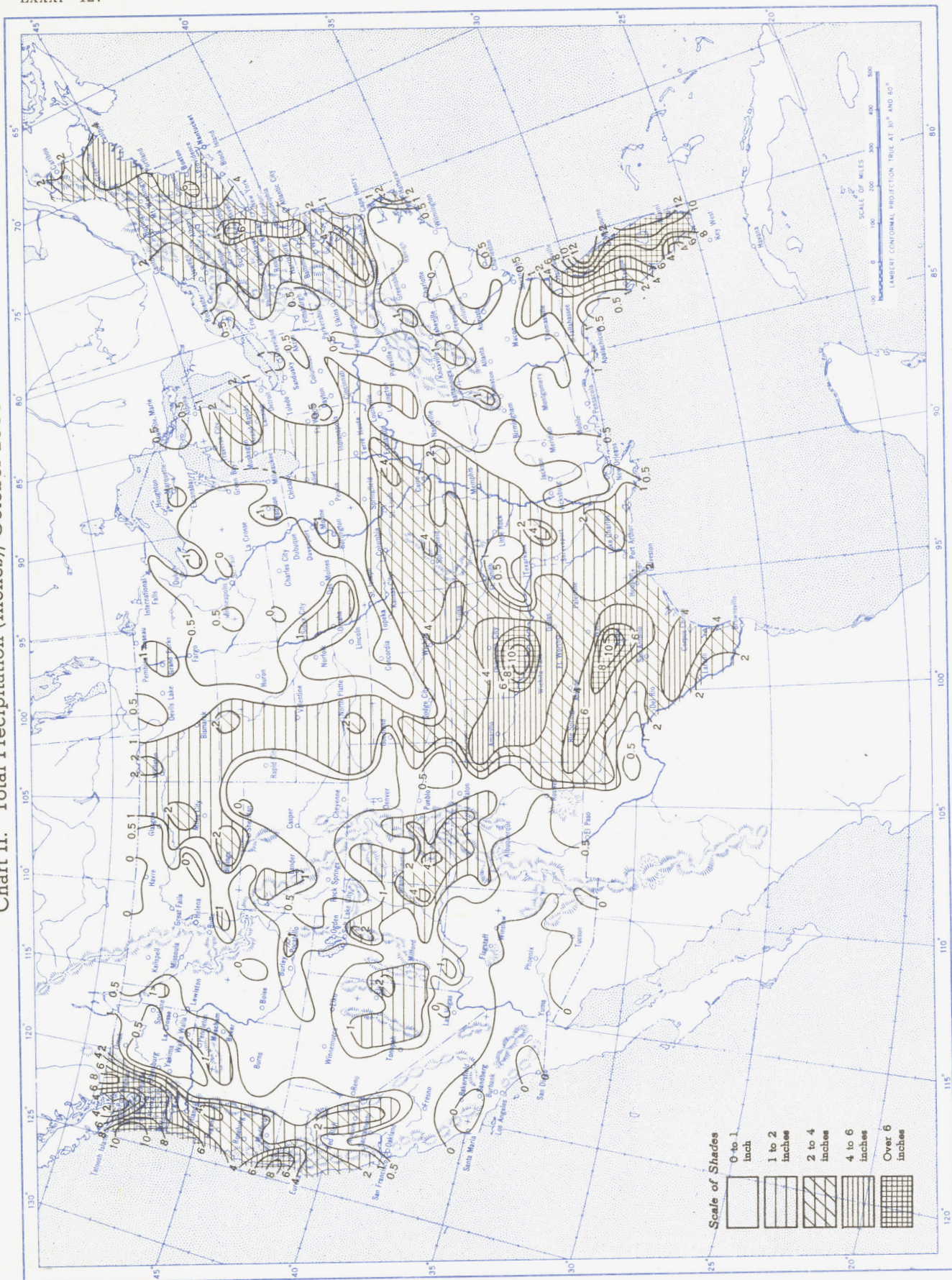
1. William H. Klein, "The Weather and Circulation of September 1953—Another Dry Month in the United States," *Monthly Weather Review*, vol. 81, No. 9, September 1953, pp. 304–308.
2. William H. Klein, "The Weather and Circulation of August 1953—Featuring an Analysis of Dynamic Anticyclogenesis Accompanying Record Heat and Drought," *Monthly Weather Review*, vol. 81, No. 8, August 1953, pp. 246–254.
3. Harry F. Hawkins, Jr., "The Weather and Circulation of July 1953," *Monthly Weather Review*, vol. 81, No. 7, July 1953, pp. 204–209.
4. Jay S. Winston, "The Weather and Circulation of October 1952—The Driest Month on Record in the United States," *Monthly Weather Review*, vol. 80, No. 10, October 1952, pp. 190–194.
5. V. J. Oliver and M. B. Oliver, "A Method for Applying Tilted-Trough Theory to Synoptic Forecasting in the Mid-Troposphere," *Bulletin of American Meteorological Society*, vol. 34, No. 8, October 1953, pp. 368–375.

Chart I. A. Average Temperature ( $^{\circ}\text{F.}$ ) at Surface, October 1953.B. Departure of Average Temperature from Normal ( $^{\circ}\text{F.}$ ), October 1953.

A. Based on reports from 800 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.

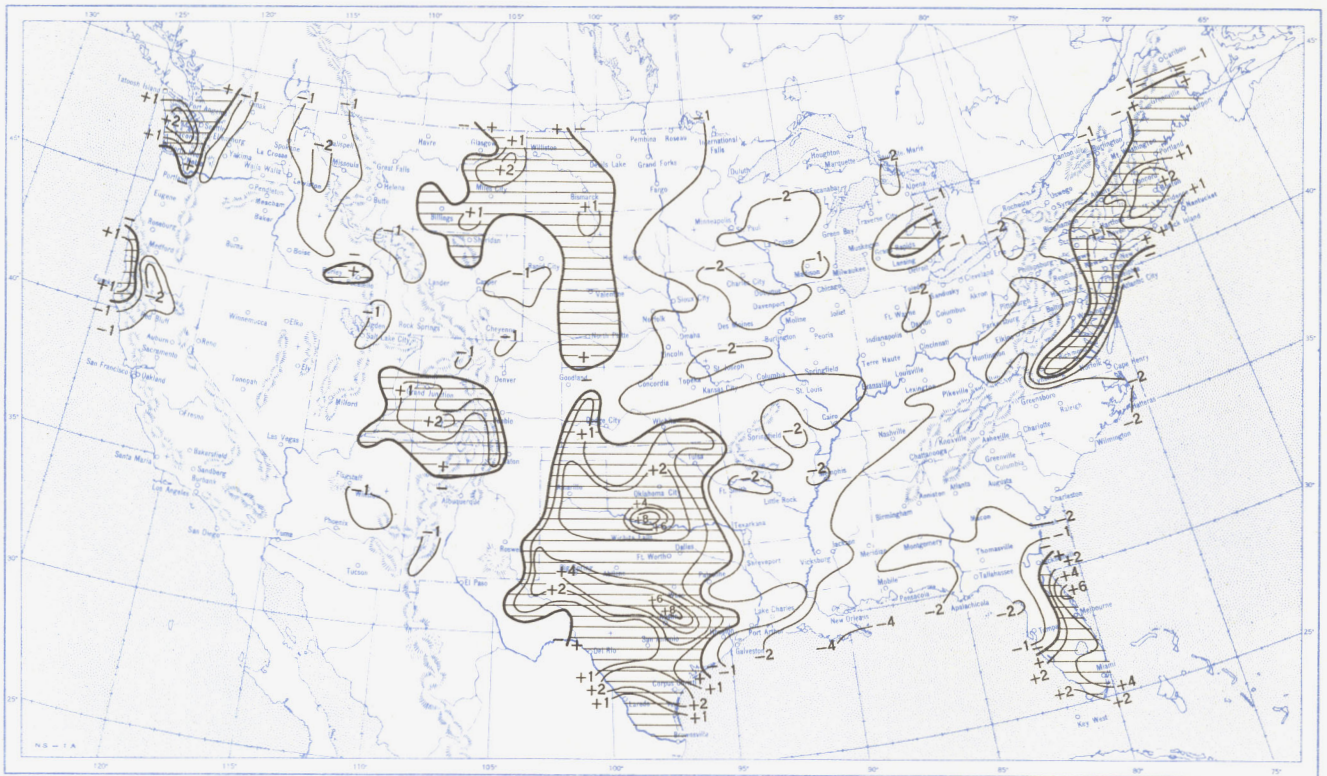
B. Normal average monthly temperatures are computed for Weather Bureau stations having at least 10 years of record.

Chart II. Total Precipitation (Inches), October 1953.

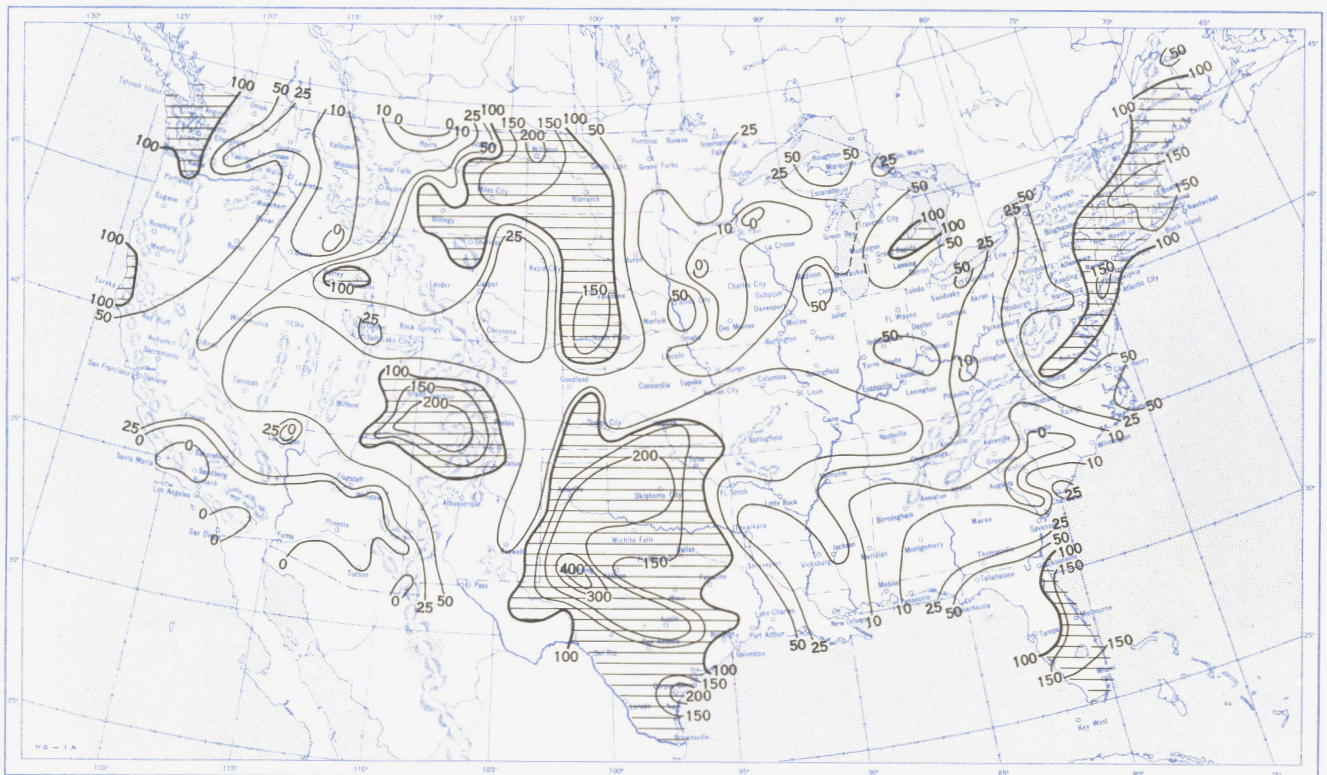


Based on daily precipitation records at 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), October 1953.

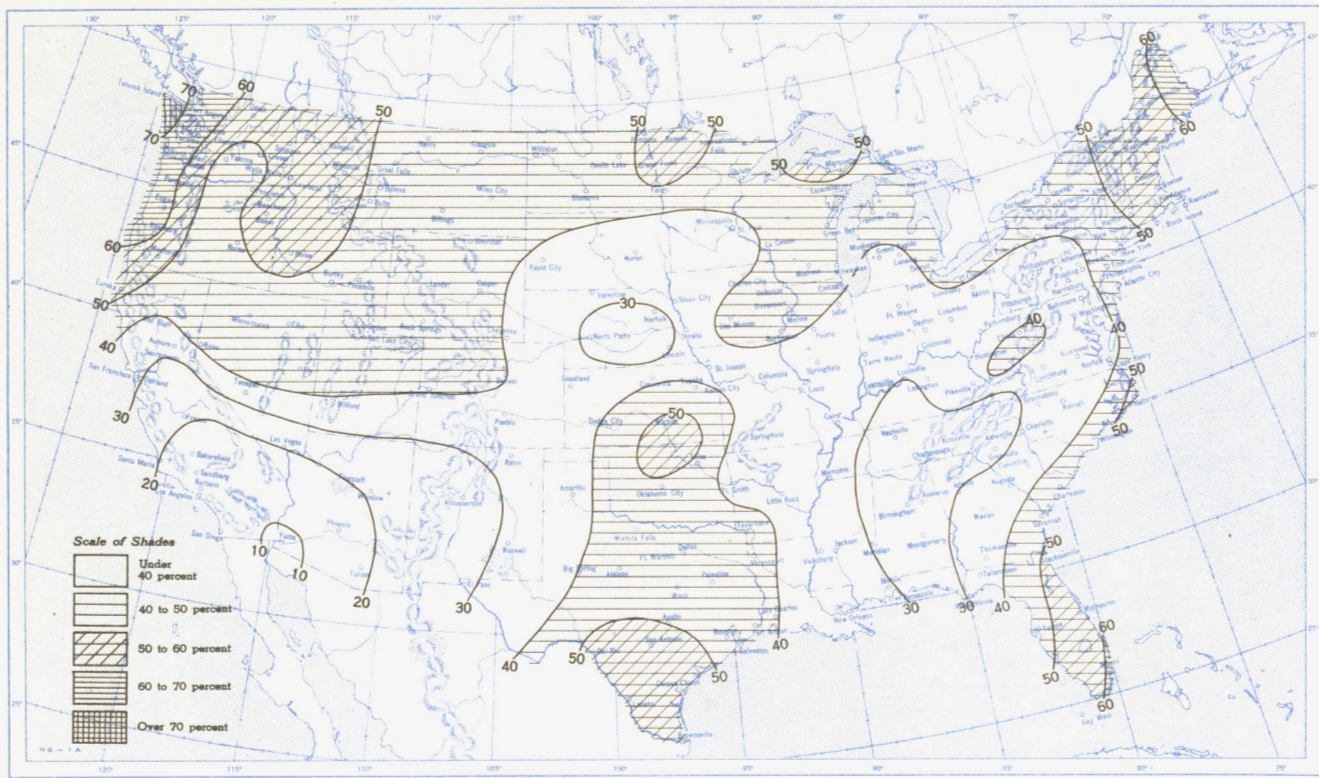


B. Percentage of Normal Precipitation, October 1953.

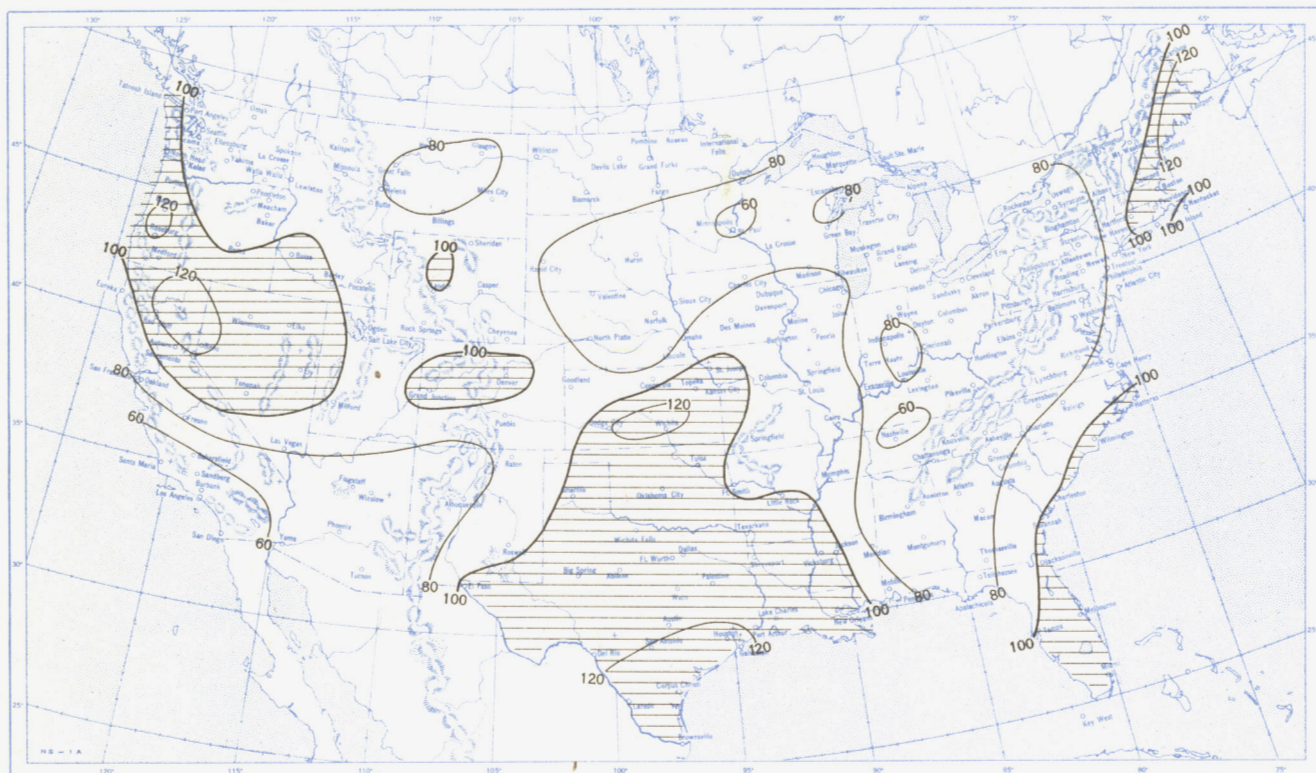


Normal monthly precipitation amounts are computed for stations having at least 10 years of record.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, October 1953.

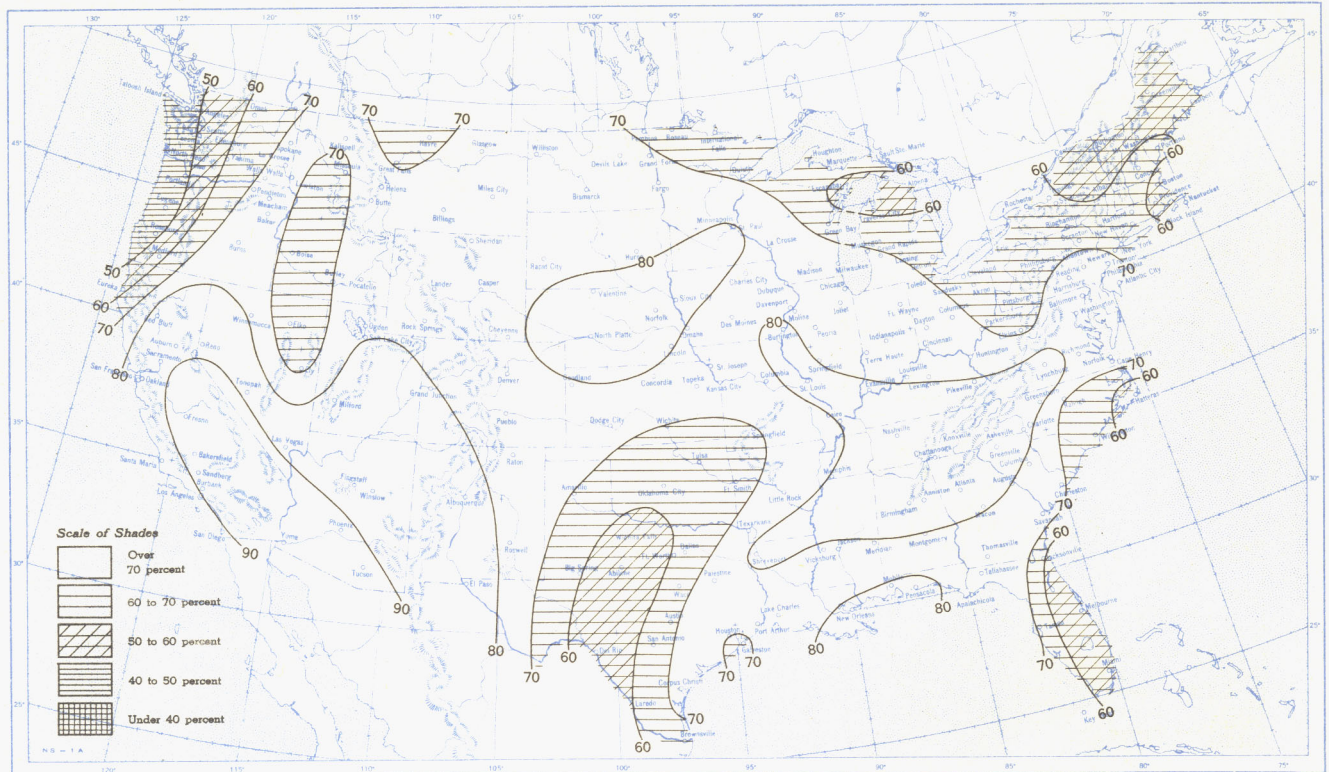


B. Percentage of Normal Sky Cover Between Sunrise and Sunset, October 1953.

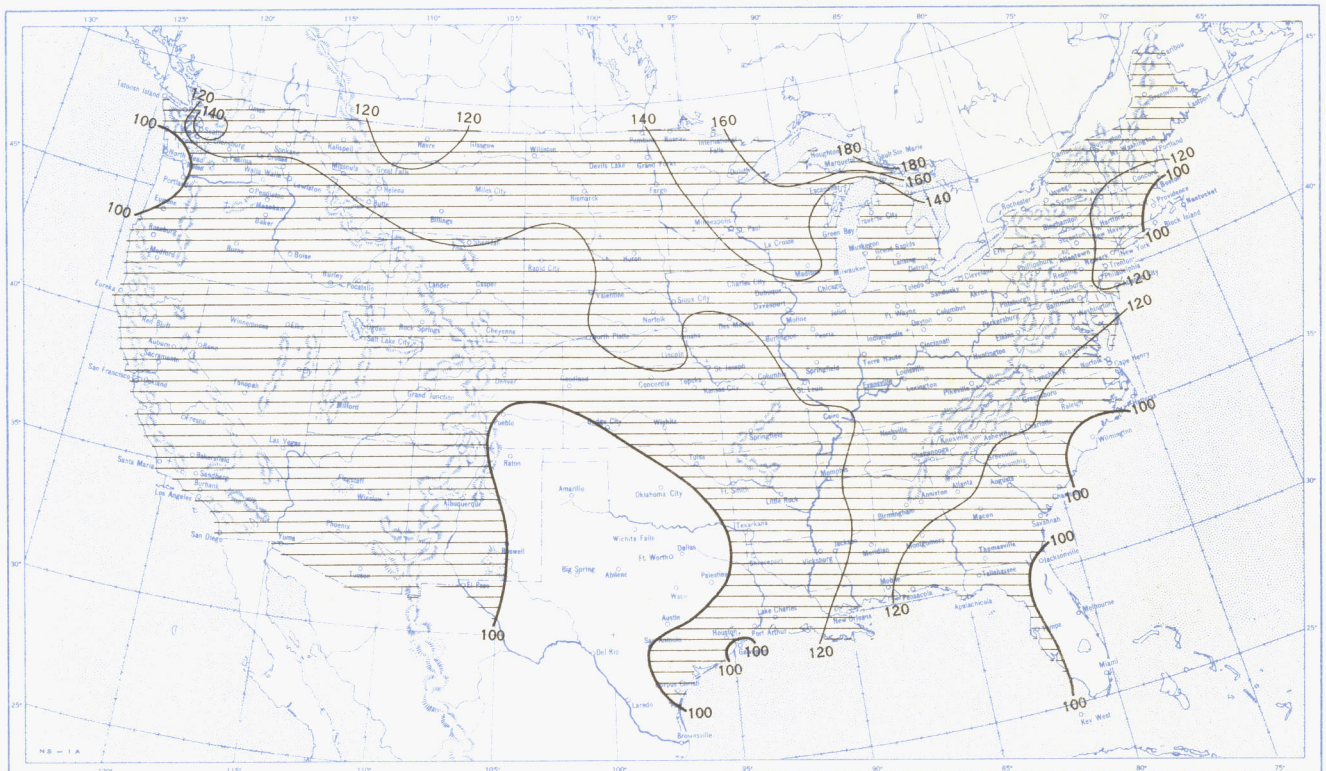


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, October 1953.



B. Percentage of Normal Sunshine, October 1953.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, October 1953. Inset: Percentage of Normal Average Daily Solar Radiation, October 1953.

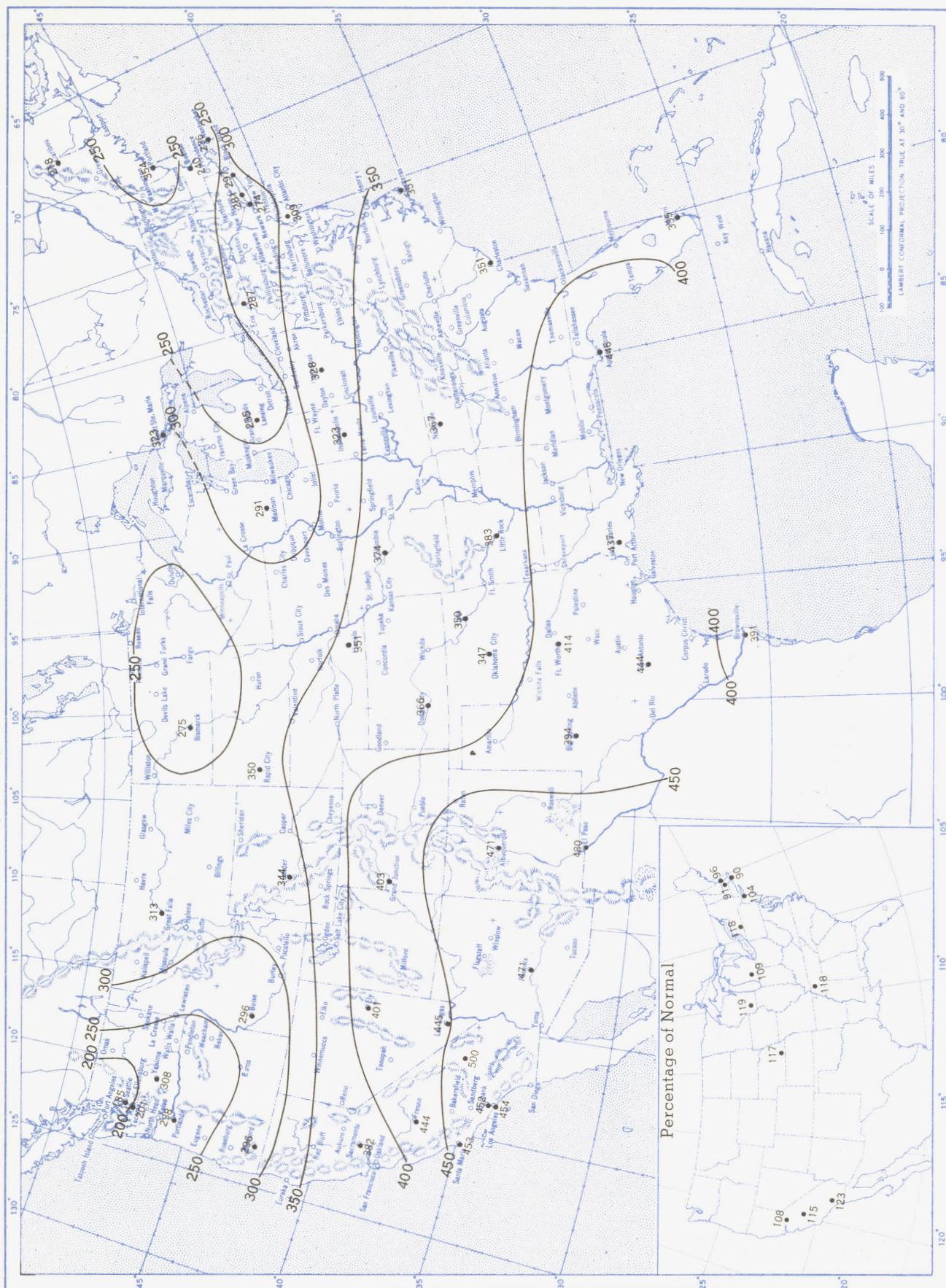


Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langleys (1 langley = 1 gm. cal. cm.⁻²). Basic data for isolines are shown on chart. Further estimates are obtained from supplementary data for which limits of accuracy are wider than for those data shown. Normals are computed for stations having at least 9 years of record.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, October 1953.

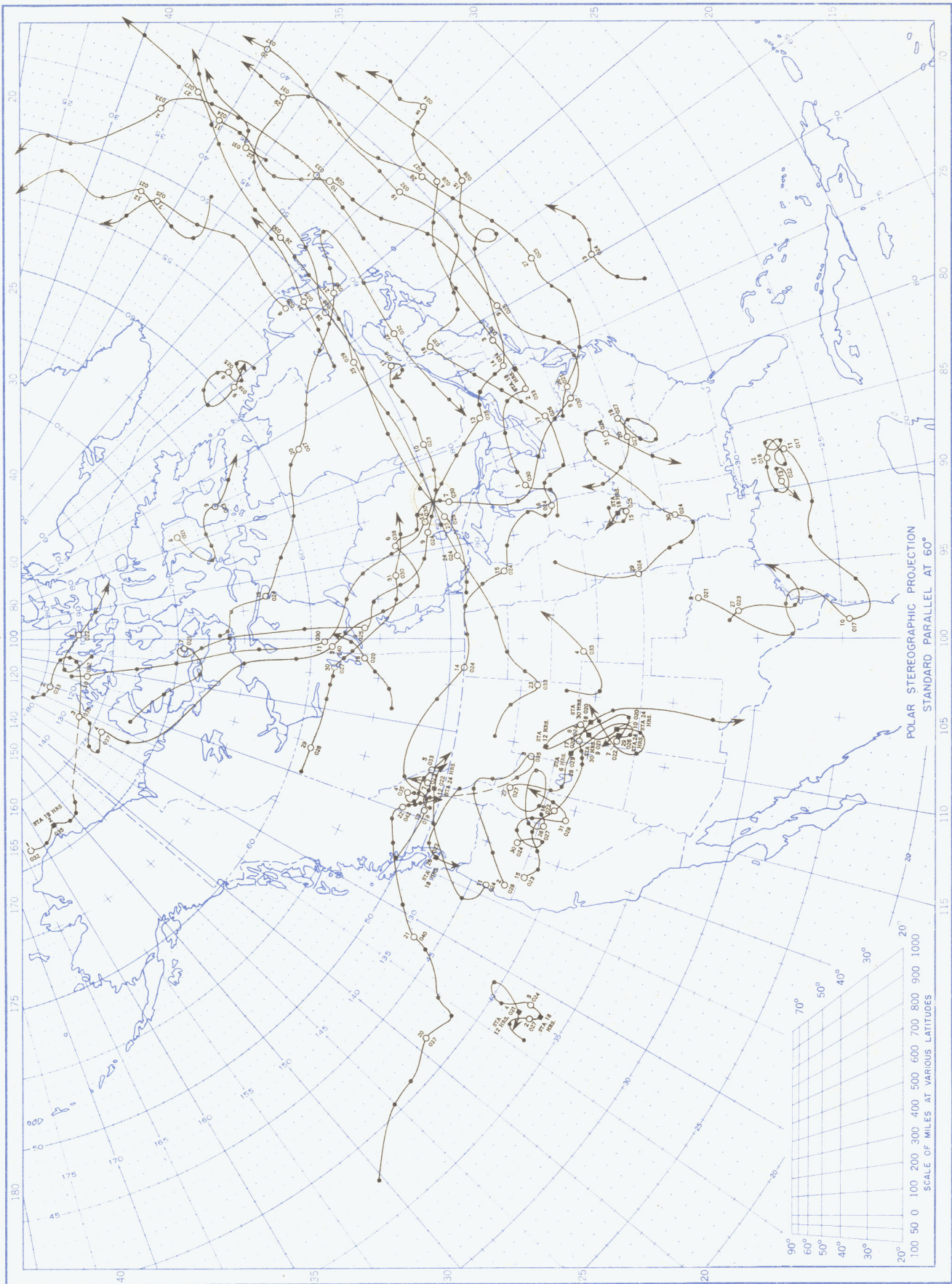


Chart X. Tracks of Centers of Cyclones at Sea Level, October 1953.

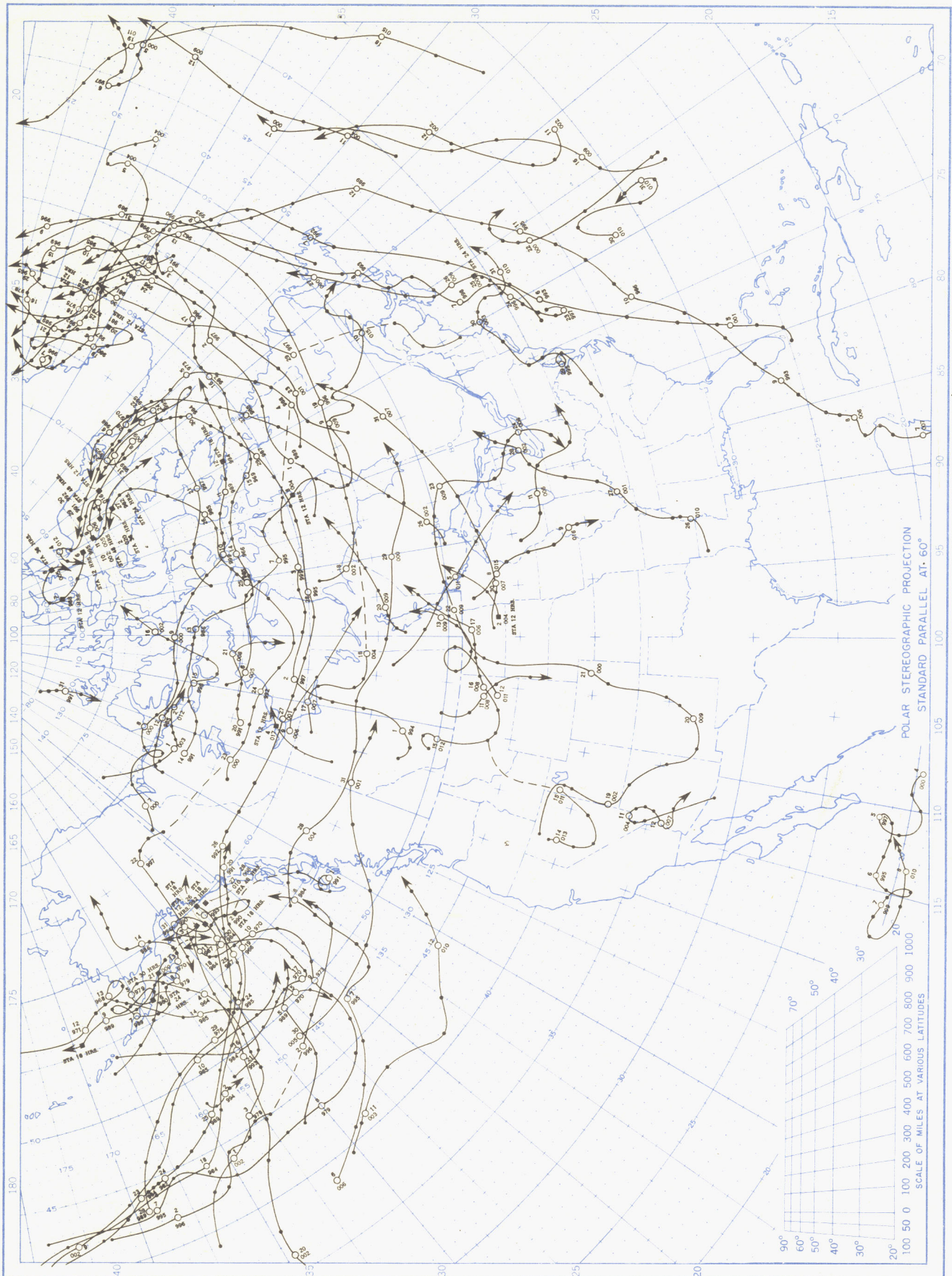
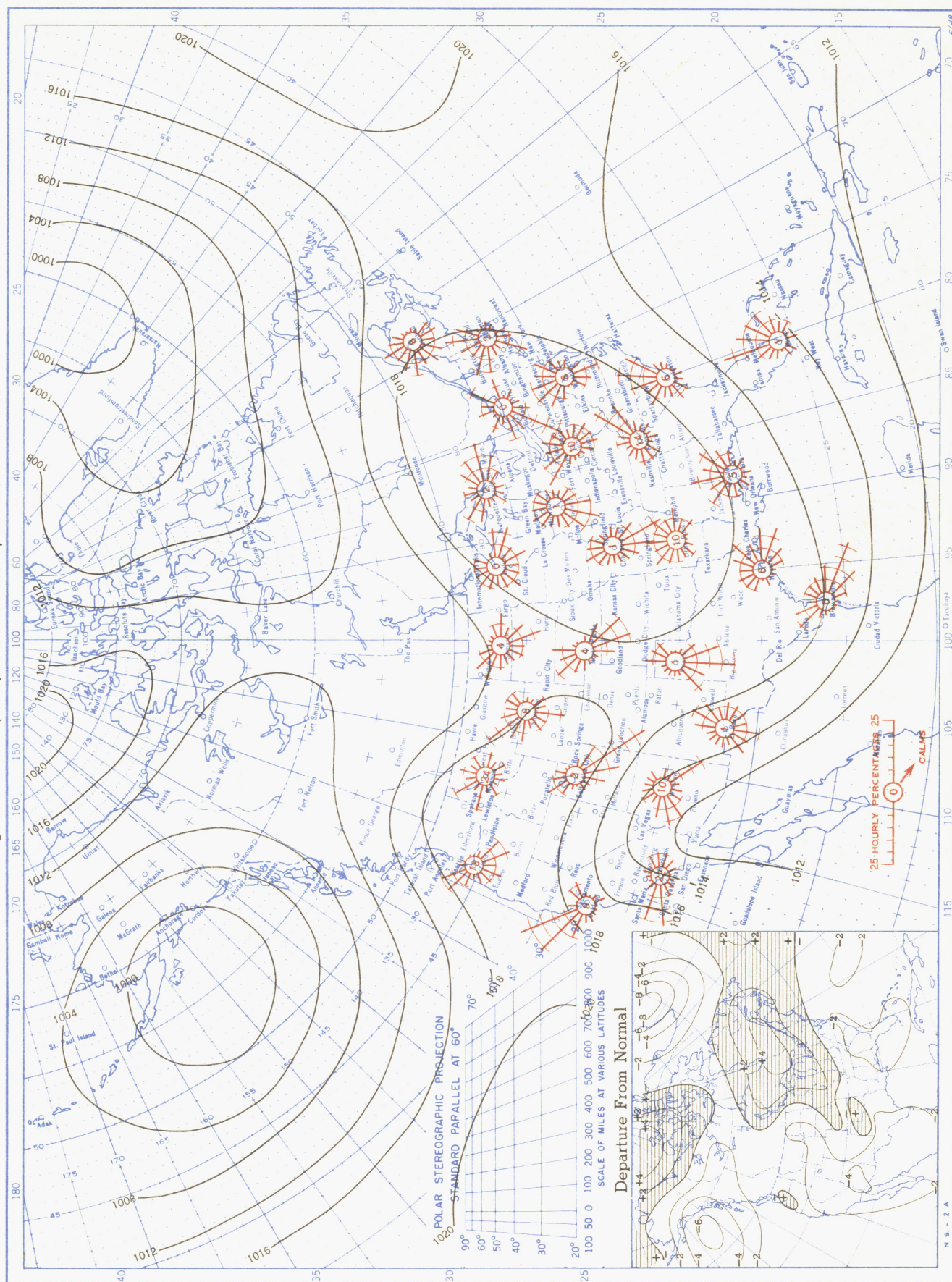
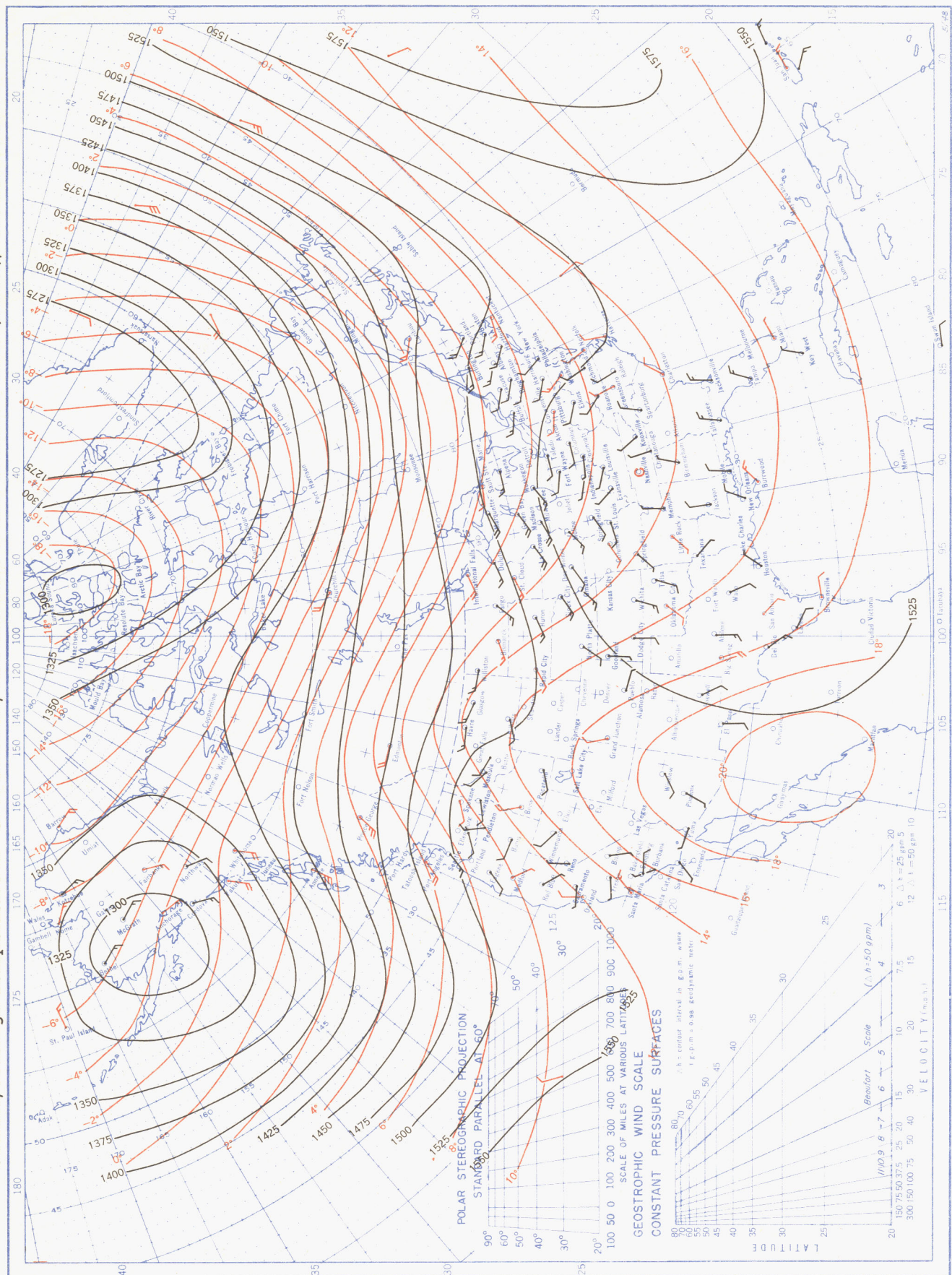


Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, October 1953. Inset: Departure of Average Pressure (mb.) from Normal, October 1953.



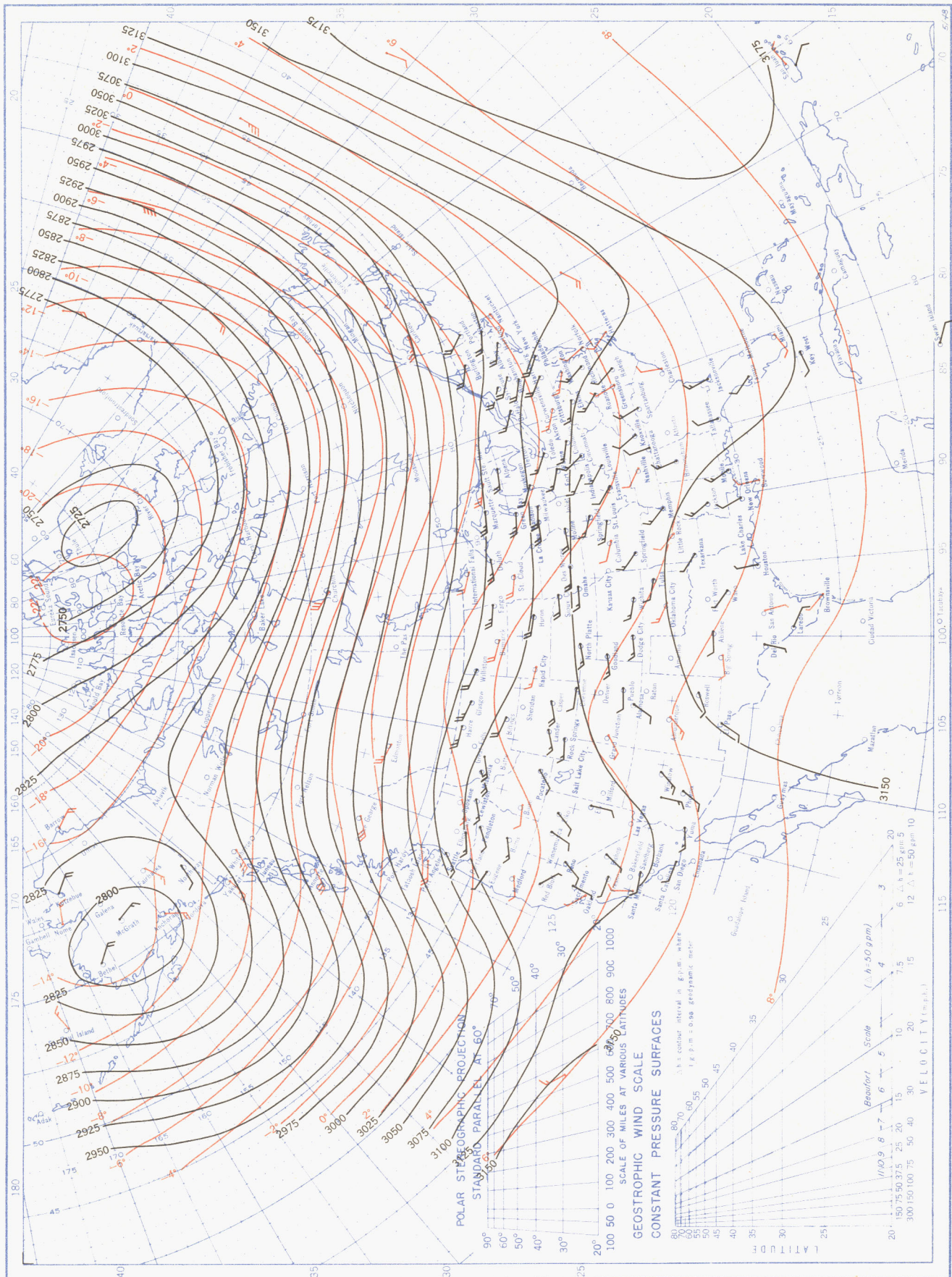
Average sea level pressures are obtained from the averages of the 7:30 a. m. and 7:30 p. m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° inter-sections in a diamond grid based on readings from the Historical Weather Maps (1899-1939) for the 20 years of most complete data coverage prior to 1940.

Chart XII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 850-mb. Pressure Surface, Average Temperature in °C. at 850 mb., and Resultant Winds at 1500 Meters (m.s.l.), October 1953.



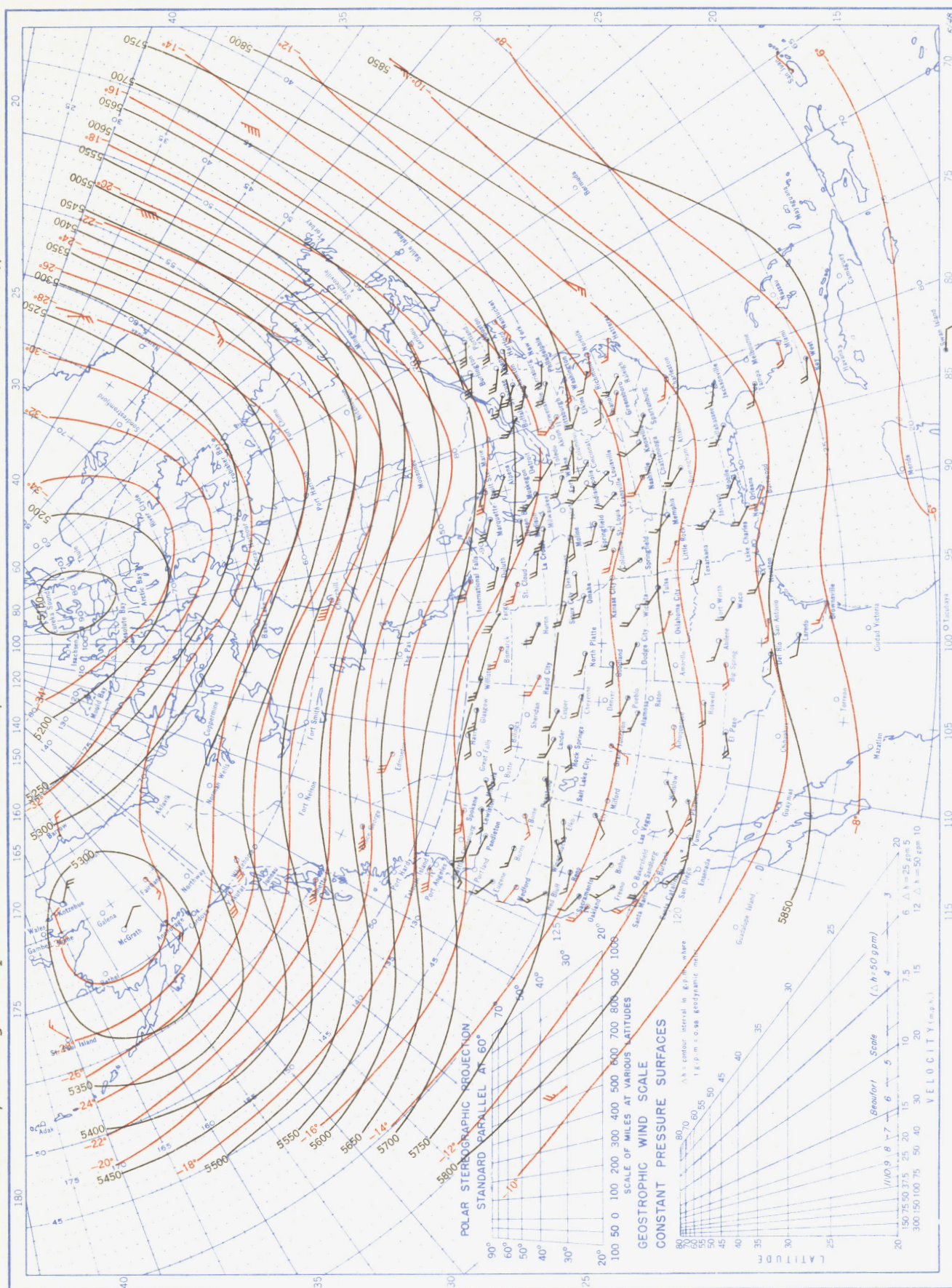
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawinsonde observations at 0800 G. M. T.

Chart XIII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 700-mb. Pressure Surface, Average Temperature in °C. at 700 mb., and Resultant Winds at 3000 Meters (m.s.l.), October 1953.



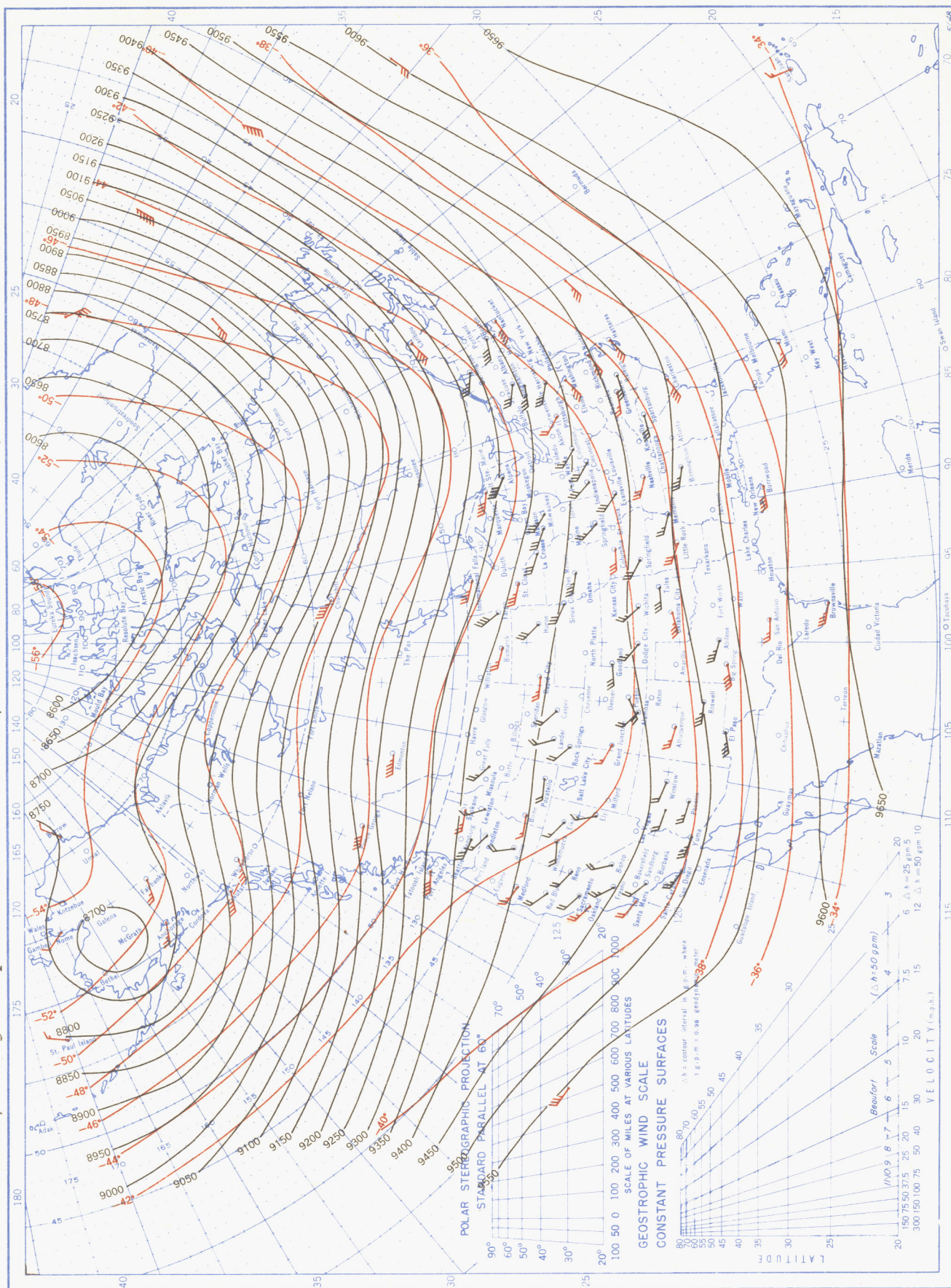
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

Chart XIV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 500-mb. Pressure Surface, Average Temperature in °C. at 500 mb., and Resultant Winds at 5000 Meters (m.s.l.), October 1953.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.

Chart XV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 300-mb. Pressure Surface, Average Temperature in °C. at 300 mb., and Resultant Winds at 10,000 Meters (m.s.l.), October 1953.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.